

Technology Reinvestment Project
Manufacturing Education and Training

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OCIT

Annual Progress Report

PRACTICE ORIENTED MASTER'S IN OPTICS

Center for Applied Optics
The University of Alabama in Huntsville
Huntsville, AL

in Collaboration with

Alabama A&M University
Normal, AL



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Contract No. NAG8-1028

Report Period: 18 March 1996 through 17 March 1997

April 15, 1997

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Brief Abstract

This award provides support for the development and initial implementation of an interdisciplinary Master's Program with a concentration in Optics and Photonics Technology. This program is a collaboration between the University of Alabama in Huntsville, Alabama A&M University, Northwest Shoals Community College, the NASA Marshall Space Flight Center, the U. S. Army Missile Command, Oak Ridge National Laboratory, the National Institute for Standards and Technology, Advanced Optical Systems Inc., Dynetics, Inc., Hughes Danbury Optical Systems, Inc., Nichols Research Corp., SCI Inc., and Speedring Inc. These organizations have been participating fully in the design, development and implementation of the program. This program is directed at both traditional students as well as government and defense workers who desire specialty education in practical optics and optical systems design and manufacturing. It is intended to produce highly trained graduates who can solve practical problems, and includes an on-site practicum at a manufacturing location.

The broad curriculum of this program emphasizes the fundamentals of optics, optical systems manufacturing and testing, and the principles of design and manufacturing-to-cost for commercial optical products.

The degrees offered are the MS in Physics and the MSE in Electrical Engineering with concentration in Optics and Photonics Technology through the Physics and Electrical and Computer Engineering departments of UAH with support from and in consultation with the Steering Committee composed of representatives from each of the participating organizations plus a student representative.

1. Introduction

An interdisciplinary Master's Program with a concentration in Optics and Photonics Technology is offered under the U.S. Manufacturing Education and Training Activity of the Technology Reinvestment Project (TRP).

A number of industries, government and academic organizations are participating fully in the design, development and implementation of this program. The program will produce highly trained graduates who can solve practical problems. It includes an on-site practicum at a manufacturing location.

The program is designed to enable full-time students and the government and industrial defense work force to transition to commercial manufacturing, enhancing their competitiveness in the global marketplace, and to expand the U. S. job base and economy. The broad spectrum curriculum of this program emphasizes the fundamentals of optics, optical systems manufacturing and testing, and the principles of design and manufacturing to cost for commercial

products. The participating organizations are providing extensive personnel and laboratory facilities to ensure successful implementation and sustainment of the program.

The MS in Physics and MSE in Electrical Engineering Degrees with concentration in Optics and Photonics Technology are offered by the respective University of Alabama in Huntsville (UAH) academic departments under the auspices of the UAH Graduate School, with support from and in consultation with the Steering Committee chaired by Dr. John O. Dimmock, Director of the Center for Applied Optics. The Committee is composed of representatives from each of the participating academic and industrial organizations, as well as a student representative from UAH.

The degree consists of thirty-three credit hours, of which twenty-seven are classroom hours in new and existing courses offered by UAH and Alabama A&M University (AAMU), and six credit hours consisting of a practicum and thesis to be executed at one of the on-site locations.

2. Activities and Deliverables

a. Current and Completed Project Activities

Table 2 summarizes the project activities and deliverables for this reporting period.

Quarterly reports for the first three quarters of the reporting period are included as Attachment 1 for reference.

1. Paul Burke has successfully defended his thesis "Fiber Optics Interferometry" and is scheduled to graduate in May 1997. In anticipation of this he has already accepted a position in industry.
2. Jeff Meier is completing his thesis on "Passive Ice Detection" and expects to complete the program this summer.
3. Five additional students have assigned thesis topics. See Attachment 2.
4. The numbers of students participating in the new courses are indicated in Attachment 3.
5. It is clear that our original expectation that students can complete this program in sixteen months was overly optimistic. With the demands of this program a mean time of twenty four months is more likely. Even this will require assigning students to projects after their first semester rather than after the second as is now done.
6. It appears that it is important to get industry involved with the students earlier and in a more significant way. We plan to initiate new student/industry meetings in the fall of 1997 to

align students with the industrial opportunities early. This should have been done from the start.

7. We ended up with only two new students in the fall of 1996 bringing the total to twelve. Although this is a very disappointing number, we have a quite large number of applicants for the fall of 1997. We are learning not to count our students until after registration.
8. The program was advertised nationally in two magazines, *OE Reports* and *Physics Today*. Flyers were sent to undergraduate physics student chapters nationally and to individual students in the North Alabama area. Inquiries were followed up with a booklet describing the program in detail.
9. Given the current and projected enrollment we anticipate that the program should be 75 to 80% self supporting by the end of the TRP support. The principal deficit will be in student financial support which we will endeavor to obtain from industry.
10. Several papers and presentations have been generated and are listed in Attachment 4.
11. Requirements for the laboratory to be associated with the optical testing course have been defined and this augmentation should be in place by next fall.
12. Dr. Joe Geary has identified the need for a further course "Introduction to Lens Design." We plan to introduce this course in the fall or spring of next year.

b. Activities Planned or Begun for the Next Reporting Period

1. Paul Burke will graduate.
2. Jeff Meier will defend his thesis.
3. Other student practicums will continue over the summer.
4. A full meeting of the students, faculty and industry representatives will be held at the start of the fall semester in August.

3. Commitment to Education

Under this program a new concentration option under the Master's of Science (Physics) and Master's of Science in Engineering (Electrical Engineering) degree programs of the University of Alabama in Huntsville was developed and approved by the Alabama Commission of Higher Education of The University of Alabama System. This concentration consists of courses offered by the University of Alabama in Huntsville and by Alabama A&M University in Normal,

Alabama. It includes four new courses focussing on practical optics design and manufacturing and on manufacturing management. It is our opinion that the combination of fundamental optical science, design and manufacturing, and manufacturing management offered under this concentration is unique. It is expected that this concentration will fully prepare students for leadership roles in practical optics and photonics manufacturing of both military and commercial products.

Currently there are three "manufacturing workforce" students in the program which is fewer than we had expected. We have again extensively advertised this opportunity to this community for the fall of 1997 matriculation. In addition to mailing flyers we have strongly encouraged the industrial and government members of the Steering Group to encourage their employees to consider this opportunity.

The University of Alabama in Huntsville has supported two students in this concentration with assistantships using funds from this contract. Several students in the program have been supported with other funds. An accounting of this will be included in the final report. The program is fully multi-disciplinary, involving courses developed and offered by the Physics, Electrical and Computer Engineering, and Industrial and Systems Engineering Departments, the Optical Science and Engineering program and the Center for Applied Optics. Establishing this multi-disciplinary program was possible only through the establishment of teamwork and partnerships across these disciplines as well as between institutions and private and public sectors.

4. Innovativeness

This multi-disciplinary concentration is new at the University of Alabama in Huntsville and we believe in the United States. The coursework includes fundamental optical science, practical optics and photonics design, fabrication, testing and manufacturing, and manufacturing management. Several of the courses include hands-on activities and the onsite practicum involves project work at industrial and government locations.

Educational materials used in the four new courses, in particular, deal directly with optical and photonic systems design fabrication, test, evaluation and manufacturing as well as manufacturing management. All of the new courses as well as the curriculum as a whole have been developed with industrial involvement and with the approval of the Steering Committee which has a strong industrial flavor. Industrial experts are involved in the development and delivery of all of the new courses offered in this concentration.

5. Target Populations

Information has been distributed several times as follows: Through the Alliance for Optical Technology to Government and defense workforce; graduating seniors locally (UAH, AAMU, Oakwood College) and nationwide; and to student chapters of the Optical Society of America. A brochure and admission form is sent to each prospective student who inquires.

Alabama A&M University, an Historically Black University, has been involved in this program from the initial planning stage. Several of the courses offered in this concentration are given at Alabama A&M, and a representative of Alabama A&M sits on the Steering Committee and contributes to the program guidance. Historically Black and Minority Institutions in the southeast which have Dual Degree Programs with UAH have been particularly targeted in our advertising campaign.

6. Resources - Leadership, Management, and Team

The project team consists of a balanced mix of faculty and industrial personnel. The names, affiliations and areas of expertise of the **key** project team members are listed as follows:

Key Project Faculty:

Name	Department	Areas of expertise
1. Dr. John Dimmock	Center for Applied Optics	Solid State Physics
2. Dr. Anees Ahmad	Center for Applied Optics	Optomechanical Engr'g
3. Dr. Mustafa Abushagur	Electrical Engineering	Optical Signal Processing
4. Dr. Llyod Hillman	Physics	Lasers and Quantum Elec.
5. Dr. Phillip Farrington	Industrial Engineering	Mfg. Systems and QC
6. Dr. Joe Geary	Center for Applied Optics	Metrology & Testing

Key Industrial Personnel:

Name	Industry	Areas of expertise
1. Dr. Robert Berinato	Dynetics, Inc.	Electro-optics
2. Mr. Philip Stahl	Hughes Danbury	Optical Fab and Testing

The overall program is guided by the Steering Group described above. The program development and management is provided by the Faculty Committee.

7. Resources - Equipment, Facilities, and Teaching/Learning Laboratories

The labs used in this program are housed in our 110,000 square foot optics building which was specifically designed for state-of-the-art optics research. It contains four floors of vibrationally-isolated and environmentally-shielded lab core, which includes over 6,000 square feet of cleanroom space.

The labs currently being used are the Virtual Prototyping Laboratory and the Optical Design Laboratory. A variety of capabilities exist to perform virtual prototyping of complex off-axis aspheric optical systems, direct transfer of optical ray traces and surfaces to AutoCAD Finite Element Analysis (FEA) programs, and CNC machines for optical parts fabrication. Software includes: AutoCAD release 13 with AME (Advanced Modeling Extension) capability, mechanical fasteners and geometric dimensioning and tolerancing symbols libraries, Autospell and a text editor. Hardware includes 486 and Pentium computers and a Hewlett-Packard Draftpro EXL color pen plotter (A-E size). The Optical Design Laboratory contains the best commercial optical design programs (CODE V, SYNOPSYS, ZEMAX, and others), in addition to a unique link to CAD and Finite Element Analysis, resulting in the ability to:

- 1) design leading-edge optical systems with tolerancing and fabrication specifications;
- 2) download to CAM; and
- 3) optimize the optical systems for manufacturability and performance.

8. Resources - Budget

This year funds were expended to:

- 1) Support two students full time.
- 2) Advertise the program in SPIE's *OE Reports* and OSA's *Physics Today* as well as group mailings to potential students.
- 3) Travel to conferences to present papers.
- 4) Purchase Zemax software and attend 1 week training seminar
- 5) Salaries for Professors, Administrators

We have received a year's extension on this program and will use the funds to support students and develop a new lens design course.

The cost sharing for the three years of the program is 1.16 of the TRP award expended.

Industrial Involvement

Tables 6 and 7 indicate the industrial involvement in the program. The involvement has been through the overall program development and guidance provided by the Steering Group, the industrial participation in the course development and delivery, and the support through the on-site practicum opportunities. Firms involved include both small business and large business as well as both defense and commercial businesses.

Personnel from Dynetics prepared and delivered four lectures for EE 570 and EE 670 courses, prepared practicum opportunities and served on the Steering Committee. Personnel from Aegis and NASA/MSFC prepared and delivered one lecture in EE/Ph 670. Nichols Research, Ball Aerospace and NASA/MSFC each funded a student's practicum. Nichols has now offered the student full-time employment. Kudi Kalu, Inc. and the University of Montreal provided labs and supervisory time for one student.

10. Assessment

This program is under continuous assessment by the Steering Committee which includes a student representative. The next Steering Committee review is planned for April 24, 1997 to evaluate the program progress in its third year. We believe that the program is generally meeting its objectives although we hope that the number of students, particularly those in industry, could be increased. The students in the program are generally pleased with the course work and schedule except in the areas of laboratory involvement and evening alternative class scheduling. These issues will be addressed as noted above. We are disappointed that it has taken considerably longer for the two original students to complete their practicum projects and graduate than originally expected. However, the students themselves do not appear to be as concerned. The projects undertaken have turned out to be more substantial than originally thought. In hindsight this should not have been a surprise. We will need to counsel incoming students to expect two years for their degree rather than the sixteen months originally planned. Further we will plan to identify industrial support for each student at the end of the student's first semester of studies rather than at the end of the second semester as has been done up until now. Further assessments are planned for February 1998. Assuming that we get another increase in students comparable to that experienced this last year, the program should be self sustainable at that time. We will also, of course, track the graduates to follow their career progress after graduation and compare it with other UAH MS and MSE graduates in Physics and Electrical Engineering during the same period to assess overall program success.

11. Current Research Support of Senior Personnel

This project is monitored by the NASA Marshall Space Flight Center.

12. Animal Care and Use, Institutional Biohazard Committee and Human Subject Certification

Not applicable.

13. Other Significant Information

None.

14. Attachments

Attachment 1: Quarterly Reports

Attachment 2: Thesis Topics

Attachment 3: Student participation

Attachment 4: Presentations/Publications

QUARTERLY REPORT

3/18/96 - 6/17/96

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Contract No. NAG-1028
UAH Account No. 5-33492

Presented to:

NASA Marshall Space Flight Center
Huntsville, AL 35899

Presented by:

Center for Applied Optics
University of Alabama in Huntsville
Huntsville, AL 35899

July 1996